Fifteen Years and 120 Genotypes Later What Have We Learned about Trialing Blueberry Cultivars in the Pacific Northwest?

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Abstract

The U.S. Department of Agriculture - Agricultural Research Service (USDA-ARS), in cooperation with Oregon State University (OSU) and the Oregon Blueberry Trial Support Group, has been running an extensive selection and cultivar evaluation trial at the OSU North Willamette Research and Extension Center (NWREC) in Aurora Oregon. Since the initial planting in 1990, over 120 genotypes have been evaluated. Over the years, the evaluation approach has been streamlined and improved based on experience and data analyses. The very practical things that have been learned include: 1) netting is essential for evaluating genotypes ripening in June and July; 2) a randomized complete block design, while not as ideal as a completely randomized design for detecting genotypic differences, is better from a practical standpoint when managing the best way to add new genotypes to the planting; 3) three replications were sufficient to detect differences that were meaningful to growers, about 2.69 t/ha vs. 1.80 t/ha with five replications; and 4) good harvests in years 4, 5 and 6 after planting was highly correlated with performance of total yield over years 3–9. As far as blueberry type was concerned, northern highbush blueberries were well adapted to the NWES site but most southern highbush were not. The southern highbush, with the notable exception of 'Legacy' and 'Ozarkblue', grew well but tended to be very low yielding due in part to mid-winter flowering. Rabbiteye blueberries grew well although their fruit quality was generally poorer than highbush blueberries. Rabbiteye cultivars that overlap with the highbush ripening season are not of much interest, whereas cultivars like 'Powderblue', which has good quality and 'Ochlockonee' that is very late ripening have excellent potential for late-season markets.

INTRODUCTION

New and potentially better blueberry cultivars are being developed around the world. In past decades, potential new cultivars were planted at many locations over several years before they were released to growers as cultivars for commercial planting. Now, with public research programs, primarily at land-grant universities, struggling with funding and the incredible growth of the blueberry industry new cultivars are more likely to be tested on commercial farms without extensive testing at research stations. The Oregon blueberry industry through the Oregon Blueberry Commission and an industry driven and funded Blueberry Trial Support Group made a strong commitment to selection and cultivar testing. The first replicated trial of over 40 selections and cultivars was planted in 1990 at the OSU-NWREC. Approximately every 2–3 years a new trial has been established since then although typically with fewer genotypes. The tremendous cost associated with establishing, maintaining and harvesting this trial has forced us to try to figure out ways to reduce costs as much as possible while still collecting data we have confidence in.

This discussion has two objectives 1) to give insight into the development of the USDA-ARS/OSU testing strategy and 2) to give some insight into what has been learned

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about the types of blueberries and genotypes that do well in the Pacific Northwest.

DISCUSSION

Experimental Design

In 1990, the first replicated trial was established at OSU-NWREC with over 40 genotypes. The site is very uniform and the trial was established as a completely randomized design with five replications. A completely randomized design is the preferred design to look at genotypic differences. However, many of the genotypes proved to be poorly adapted and were removed after a short trial period. Unfortunately, as new genotypes were planted for testing, the only available plots were scattered randomly over the planting. Over time this left the planting with several completely randomized yield trials together in a multi-age overall planting that was difficult to manage. Since smaller numbers of new genotypes are being planted, a randomized complete block design has proven more practical as it keeps similar aged plants together, allows for better management of the planting, and facilitates new plantings.

Five replications clearly differentiated the genotypes performance, however they were more than was needed to estimate differences due to genotype and the extra precision did not make the data any more reliable for the research program or the industry than would fewer replications. Steel and Torrie (1980) outlined procedures to estimate the size necessary for an experiment to be able to detect specific differences. Using data that had been collected over the first nine years of the trial, these procedures estimated that five replications detected 1.80 t/ha differences while four and three replications detected 2.24 and 2.69 t/ha differences. Since that time, only three replications have been planted as this gives enough confidence to assess whether cultivars are high, moderate or low yielding.

Bird Netting Essential for Summer Harvest

Initially the trial was established without bird netting. While we hoped that the 3rd year crop would be sufficient to feed the birds and still leave enough for a yield assessment, this was not the case. In addition to losing a tremendous amount of blueberries, fruit that had just colored had to be harvested to try to beat the birds to them. While this may have been acceptable for yield determination it negatively impacted the evaluation of fruit quality. Since 1994, the main season, highbush blueberry trial has been netted. In the Pacific Northwest, the birds seem to move on to other crops by August and so a late season, rabbiteye trial was established without netting. The first large harvest of this unetted trial was in 2007 and there appeared to be no significant bird predation. We presume this is because they birds have moved on to other crops as opposed to just not liking rabbiteye blueberries!

Good Harvests in Years 4–6 Predict Genotypic Differences

In the initial trial established in 1990, there were 13 cultivars that were harvested in years 4-9 after planting, as year 3 was lost to bird predation. Nine years is a long time to maintain a planting and the harvest costs can be tremendous. In order to get a rough idea of what combination of year's results was predictive of the cumulative yield in the trial, a correlation was run between single years, and various 2–6 year combinations with the cumulative yield. Harvest in year 4–6 was very strongly ($r=0.916$, $p\leq0.001$) correlated with the cumulative yield for years 4–9. In a smaller subset planted in 1992 that looked at years 3–5 correlated with years 3–9 there was also a strong correlation ($r=0.90$) but it was not significant. Harvesting an additional one or two years only slightly improved the correlation in the larger group of genotypes, $r=0.921$ ($p\leq0.001$) and 0.928 ($p\leq0.001$) for years 4–7 and 4–8, respectively. Our standard practice is to strip the crop in years 1 and 2 and begin harvest in year 3. If the plants have grown well, results from year 3 will begin to give a good idea of yield potential and if they have not grown well it still gives an early read on fruit quality. Years 4–6 are further harvested to determine yield if a genotype has

not been discarded based on other evaluations.

Use Commercial Quality Planting Stock When Possible

Ideally, any trial will use uniformly sized and aged plants. Ideally, a relationship with a commercial nursery can be developed where plants of promising selections, new cultivars or standards can be produced under uniform protocols. Fall Creek Farm and Nursery (Lowell, Ore) has been very willing to work with the USDA-ARS and OSU to facilitate this. As the breeding program has developed, this has required the development of safeguards ensuring any plant material sent to the nursery for propagation is free of disease, particularly virus.

The Good, the Bad and the Ugly of Cultivars Tested in Our Trials

Table 1, which groups cultivars from multiple plantings over different years allows for a rough comparison of performance in the trial over 17 years. While interesting and valuable, decisions on what is worth pursuing or discarding are made based on the analysis of single aged plantings.

The cultivars tested have had a wide range of harvest seasons (Fig. 1). In the initial harvest season, especially when predation was a concern, the trial was harvested weekly as the fruit ripened. Since the industry was moving to primarily machine harvesting, the approach to picking was modified and now fruit is left on the bush until the entire crop appears to be mostly ripe. As a consequence of this approach to harvest, the 5% and 50% harvest date are often the same. While this accurately reflects what most growers using machines would face and significantly reduces harvest costs, it does make it difficult for growers who are hand picking for the fresh market to get a clear picture of when a genotype has its first harvestable fruit.

Testing of these cultivars, and another 60+ advanced selections from breeding programs, has had two immediate impacts. First, it points to cultivars that are suited for the industry and two, of equally or greater importance, it identifies cultivars that either should not be planted or should truly be tested by the grower before substantial acreage is planted. From an economic standpoint, bringing a cultivar into production that turns out to be ill adapted is much more costly than dealing with a cultivar brought into production that is commercially viable but not ideal.

Generally, the southern highbush blueberries that behave like southern highbush (e.g., 'O'Neal', 'Blue Ridge') are not good choices for the Northwest as they are low yielding and have poorer yields and fruit quality than northern highbush. There are some exceptions, as a few southern highbush behave more like northern highbush, (e.g., 'Legacy' and 'Ozarkblue') and do very well commercially. Rabbiteye blueberries are primarily of value in the very late ripening season. 'Powderblue' has been the standard and most cultivars tested in comparison to it have neither the fruit quality nor the yield that it has, although 'Ochlockonee' may be an exception. As you move north into the Puget Sound area of Washington and the Fraser River Valley in British Columbia, there are much fewer heat units during the growing season than in Oregon. This factor seems to negatively influence growth in many of the southern highbush cultivars and prevents most rabbiteye blueberries from ripening a good crop. While the highbush blueberries 'Elliott' and 'Aurora' are being grown or trialed in these areas, long time growers voice concerns about their inability to get 'Elliott' to ripen in past decades.

Cultivars that are not considered commercially viable in the Pacific Northwest production, either due to poor yield, poor adaptation, poor fruit quality and/or disease susceptibility include: Berkeley, Bluechip, Bluegold, Blue Ridge, Bluetta, Bounty, Cape Fear, Chanticleer, Craven, Duplin, Echota, Georgiagem, Hannah's Choice, Jubilee, Little Giant, Maru, Nelson, Northland, Nui, O'Neal, Pearl River, Puru, Reveille, Sampson, Sierra, Summit, and Sunrise.

Cultivars that are recommended based on trial results and commercial grower experience include in order of ripening: Duke, Spartan, Draper, Reka (processing only), Bluejay, Bluecrop, Rubel (small fruit market), Legacy, Liberty, Chandler (fresh, hand

harvest only), Ozarkblue, Elliott, Aurora, and Powderblue. Several other cultivars have niche markets or are very good for some growers but are not universally viable, these include: 1613A/"Hardyblue" (processing only), Brigitta Blue (unreliable; often low yields), Earliblue (earliest primary fruit), Jersey (processing only), Olympia (excellent for local sales), and Toro (does not machine harvest well).

CONCLUSIONS

The 1990s and early 2000s brought an abundance of new cultivars into the marketplace. Some of these such as 'Duke' have become overwhelming commercial successes and others appear headed in that direction. In 17 years of testing advanced selections and cultivars, a practical approach to evaluating these has been developed that balances the needs of an experimental setup that allows for statistical analyses with the high costs of labor to maintain and harvest a large replicated trial.

Literature Cited

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Tables

Table 1. Yield for 57 cultivars planted in various replicated and observation trials over the past 17 years in the USDA-ARS/OSU cooperative breeding program at NWREC. "-" denotes cultivars that were either discontinued from harvest due to poor quality, ones that have yet to be harvested for 3–5 or 4–6 years after planting, or ones whose yield was lost in 1993 due to bird predation. Where a number follows a name (i.e., Bluecrop 90) that number indicates the planting year.

Cultivar	Planting year	1st harvest year	Number of years harvested	Mean yield (t/ha)		
				All years harvested	Years 3-5 after planting	Years 4-6 after planting
Harvested for three or more years						
1613A ("Hardyblue")	1994	1997	5	7.45	7.34	6.50
Aurora	2001	2003	5	10.23	8.43	9.01
Berkeley	1990	1994	3	6.40	-	6.40
Blue Ridge	1990	1994	3	6.65	-	6.65
Bluechip	1990	1994	3	2.42	-	2.42
Bluecrop00	2000	2002	5	10.91	12.16	11.87
Bluecrop01	2001	2003	5	5.60	4.62	7.75
Bluecrop02	2002	2004	4	8.05	5.85	-
Bluecrop90	1990	1994	6	12.71	-	6.58
Bluecrop96	1996	1999	6	10.22	9.03	9.42
Bluegold	1990	1994	5	5.83	-	4.15
Bluejay	1990	1994	4	8.32	-	6.91
Brigitta Blue	1996	1999	6	11.99	7.29	9.87
Cape Fear	1990	1994	3	6.35	-	6.35
Chandler	1996	1999	6	12.61	6.92	9.33
Chanticleer	1990	1994	4	1.87	-	1.75
Darrow	1994	1997	5	11.49	8.98	9.76
Draper	2001	2003	5	7.84	6.14	7.61
Duke00	2000	2002	5	6.57	6.00	6.86
Duke90	1990	1994	6	8.57	-	4.93
Duplin	1990	1994	3	4.11	-	4.11
Earliblue	1990	1994	6	7.71	-	4.03
Echota	1990	1994	6	16.35	-	9.45
Elliott00	2000	2002	5	12.85	14.23	12.61
Elliott90	1990	1994	6	17.00	-	11.47
Georgiagem	1990	1994	4	7.96	-	5.86
Hannah's Choice	1990	1994	4	4.47	-	3.37
Jersey	1990	1994	3	7.62	-	7.62
Jubilee	2001	2003	4	3.55	-	1.33
Legacy	1990	1994	6	13.75	-	5.91
Liberty	2001	2003	5	6.10	4.95	8.94
Nelson	1990	1994	4	6.45	-	5.29
Northland	1990	1994	3	6.27	-	6.27
Nui	1992	1994	8	9.59	4.79	6.72
O'Neal	1990	1994	4	5.97	-	4.85
Ozarkblue	1996	1999	6	11.57	10.67	10.91
Pearl River	2000	2002	5	0.96	1.45	1.45
Powderblue94	1994	1997	9	14.70	6.55	9.41
Puru	1992	1994	8	11.45	6.35	9.81
Reka	1992	1994	8	13.79	6.72	9.55
Reveille	1990	1994	3	4.44	-	4.44
Rubel	2000	2002	5	4.51	4.32	5.44
Sampson	1990	1994	5	10.95	-	6.14
Sierra	1990	1994	3	3.73	-	3.73
Spartan	1990	1994	6	13.04	-	7.72
Summit	1996	1999	4	7.51	7.68	8.29
Sunrise	1990	1994	3	4.48	-	4.48
Tifblue	1994	1997	9	11.21	6.04	9.33
Toro	1990	1994	6	13.35	-	6.90

Table 1 (continued). Yield for 57 cultivars planted in various replicated and observation trials over the past 17 years in the USDA-ARS/OSU cooperative breeding program at NWREC. "-" denotes cultivars that were either discontinued from harvest due to poor quality, ones that have yet to be harvested for 3–5 or 4–6 years after planting, or ones whose yield was lost in 1993 due to bird predation. Where a number follows a name (i.e., Bluecrop 90) that number indicates the planting year.

Cultivar	Planting year	1st harvest year	Number of years harvested	Mean yield (t/ha)		
				All years harvested	Years 3-5 after planting	Years 4-6 after planting
Harvested one or two years						
Blueray	1990	1994	2	5.69	-	-
Bluetta	1994	1997	2	2.81	-	-
Bounty	1990	1994	2	2.16	-	-
Columbus	2004	2006	2	0.35	-	-
Craven	2004	2006	1	2.97	-	-
Delite	2004	2006	2	3.04	-	-
DeSoto	2004	2006	2	4.72	-	-
Lenoir	2004	2006	1	5.12	-	-
Little Giant	2000	2002	2	3.13	-	-
Maru	2004	2006	2	1.08	-	-
Ochlockonee	2004	2006	2	4.35	-	-
Onslow	2004	2006	2	3.03	-	-
Pamlico	2004	2006	1	4.42	-	-
Powderblue04	2004	2006	2	1.39	-	-
Rahi	2004	2006	2	0.94	-	-

Figures

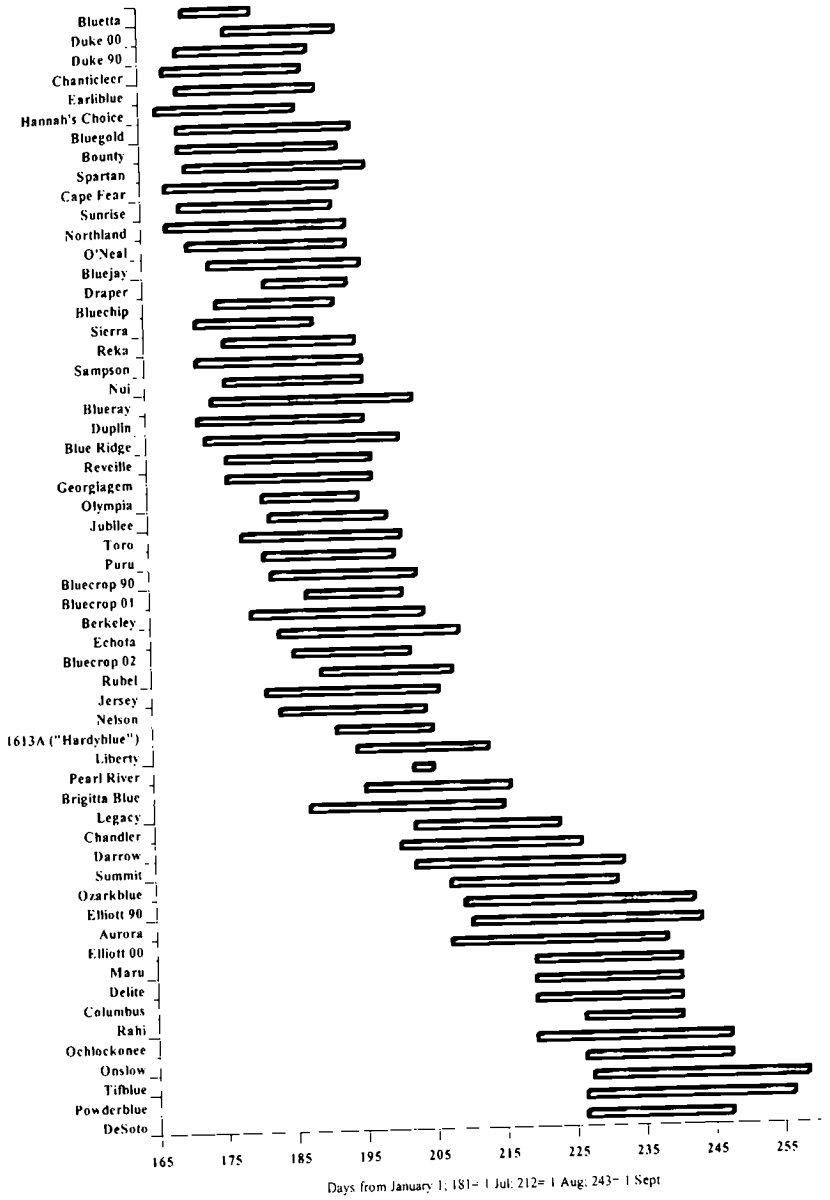

Fig. 1. Harvest season (5-95%) for blueberry cultivars grown in USDA-ARS/OSU program at the North Willamette Research and Extension Center (Aurora, Ore.) in 1993-2007. There are 2–10 years in each mean and they are sorted by mean 50% harvest date. Where a number follows a name (i.e., Bluecrop 90) that indicates the planting year.